McKay's Minimum Energy Loss Culvert

The problem

In the late 1950s, the development of the main business and shopping centre of Redcliffe was severely restricted by Humpybong Creek which physically divided the town. In addition, parking area for shoppers was seriously inadequate.

The conventional solution would have required a wide culvert whose design to cope with the extreme rainfall events of the area was difficult, and whose construction would have cost more than the city could afford. Also, the energy losses in the disturbed, turbulent flow caused by the culvert would have resulted in higher flood levels upstream.

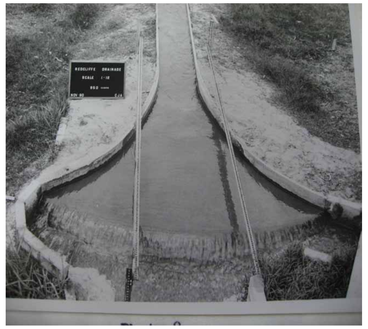
Humpybong Creek Mouth, circa 1960.
(Photo 000416, courtesy Moreton Bay Regional Council).

The Concept

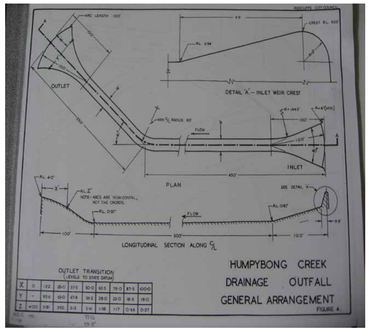
Redcliffe City Council Engineer Bill Bremner asked Dr (later Professor) Gordon McKay of the University of Queensland Civil Engineering Department to investigate the problem to see if there was a practical and economical solution. A model for a flood bypass for a river near Karlsruhe in Germany, tested in 1913/14, featured a streamlined curved inlet to a long culvert whose bed was set below the riverbed. The tests indicated significantly low energy losses by avoiding turbulence. The proposed design was never built, but McKay may have adapted the German idea to Humpybong Creek's outfall to Moreton Bay, producing a culvert with smooth streamline flow that would not cause higher flood levels upstream.

Testing McKay's Concept

In 1960, a hydraulic model was constructed in cement mortar at the University. At the entrance to the model, a wide retention weir formed an upstream lake. Runoff from storms would flow over the weir smoothly down a slope converging to a channel of uniform width. At the outlet, the water flows smoothly over an upward slope with diverging sides and over a reverse weir just above highest tide level, preventing backflow of tidal salt water from the Bay. Civil Engineer Dr (later Professor) Colin Apelt carried out the tests and documented the results in February 1961.



Flow over the model outlet weir, (equivalent to 27 cubic metres per second in the creek).



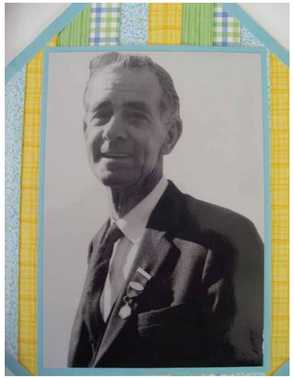
The final design.

The Solution

The model enabled several configurations to be tested at flows up to 27 cubic metres per second, the estimated maximum for the catchment when fully developed. The optimum design from the model enabled maximum energy conservation through the culvert and resulted in streamlined flow and no buildup of water level leading into the structure.

The Structure is Built and Delivers

This Minimum Energy Loss Culvert was constructed in 1961 by the Council day-labour force under the supervision of Redcliffe City Deputy (later Chief) Engineer Kevin Tibbits, at a cost around half that of a conventional culvert. It has performed since then as predicted in the model tests, enabling storm flood flows in the Creek to be handled without ever causing upstream flooding. It solved the city's creek outfall problem much more economically than would have been possible with a conventional culvert.



Professor Gordon Reinecke McKay.

McKay's Concept Travels

McKay's Minimum Evergy Loss Culvert concept has been adopted in many situations in Australia and has been favourably reviewed in many international publications. Large savings have resulted in both construction and maintenance costs compared with conventional culvert design.

This Australian project was a world-first in hydraulic engineering, pioneering the use of Minimum Energy Loss structures and so justifying the award of Engineering Heritage National Landmark By Engineering Heritage Australia.

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